Overview of MineSight® Tools

FOR MEDIUM & SHORT TERM PLANNING

BACKGROUND

Mintec, Inc. offers a suite of software products for medium and short term planning, which produce an optimum mine scheduling solution within user-defined parameters. This is commonly referred to as a "best feasible" solution. Together, these programs will satisfy your scheduling needs while providing easy implementation, reporting, schedule verification, and updating.

The MineSight Short Term Planning (STP) suite includes:

- MineSight Interactive Planner (MSIP)
- MineSight Haulage (MSHaulage)
- MineSight Schedule Optimizer (MSSO)
- MineSight Axis (MSAxis)

MineSight Axis consists of four modules. The two modules relevant to this article are:

- MineSight Axis Drill & Blast (MSAxis D&B)
- MineSight Axis Grade Control (MSAxis GC)

All of the STP tools access the MineSight Planning Database (MSPD) for data storage, retrieval, and reporting.

This article will discuss the general steps to create an optimized medium or short term plan utilizing these tools.

SOLUTION OVERVIEW

Each MineSight STP tool performs a unique function, the results of which add to the completion of the short term plan. The order in which these tools may be used will generally follow the sequence described to the right, but may change based upon company planning protocol or unforeseen changes in material destination, haul route, or material or equipment availability.

CREATING A PLAN

To create an STP, you should have a block model containing grade, topography, and density information, as well as pit pushback surfaces. Although the actual order of the tool usage is flexible, the following general steps can be used to create the plan:

1. Use MSIP to create mining cuts
2. Organize the haul network using MSHaulage
3. Schedule mining cuts using MSSO
4. Design and export blast patterns (BPs) using MineSight 3D (MS3D) Blast Pattern Editor (BPE)
5. Use MSAxis D&B to:
   - Check BPs
   - Import actual BPs
   - Calculate key performance indices (KPIs) for actual BPs
   - Report blasthole information
   - Model actual blast pattern KPI data
6. Use MSAxis Grade Control and MSIP to:
   - Optimize material classification
   - Create material routing cuts
   - Confirm material classification
   - Report cut reserves

Step 1 Use MSIP to Create Mining Cuts

MSIP creates mining cut polygons. These cuts may be created manually or semi-automatically. The semi-automatic method allows you to target on various mining constraints such as material, tons, or cut dimensions.

When creating cuts using the semi-automatic method or when reporting cut characteristics, a block or gridded seam model containing grade/quality, topography, and density information is referenced.

Cuts may be assigned user-defined attributes having values related to scheduling such as phase or period number, equipment use, and truck or shovel assignment. All cut information is stored in the MSPD.

Cut characteristics such as volume, tons, and grade information can be reported using standard reporting scripts found in the MineSight installation folder. You have the option to report non-standard cut information by modifying these scripts directly or by requesting customized enhancements be performed by Mintec, Inc.

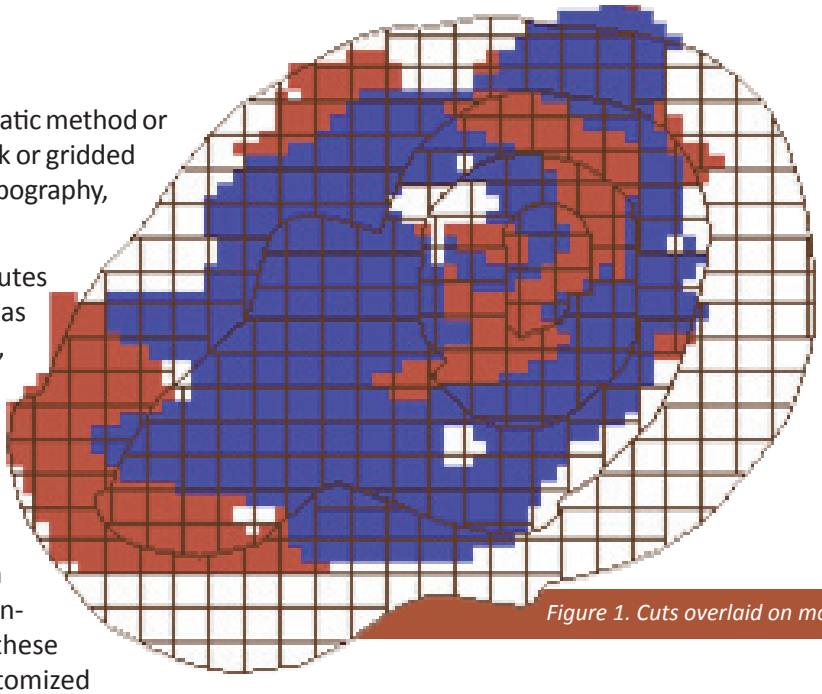

Figure 1. Cuts overlaid on model blocks.

Step 2 Organize the Haul Network Using MSHaulage

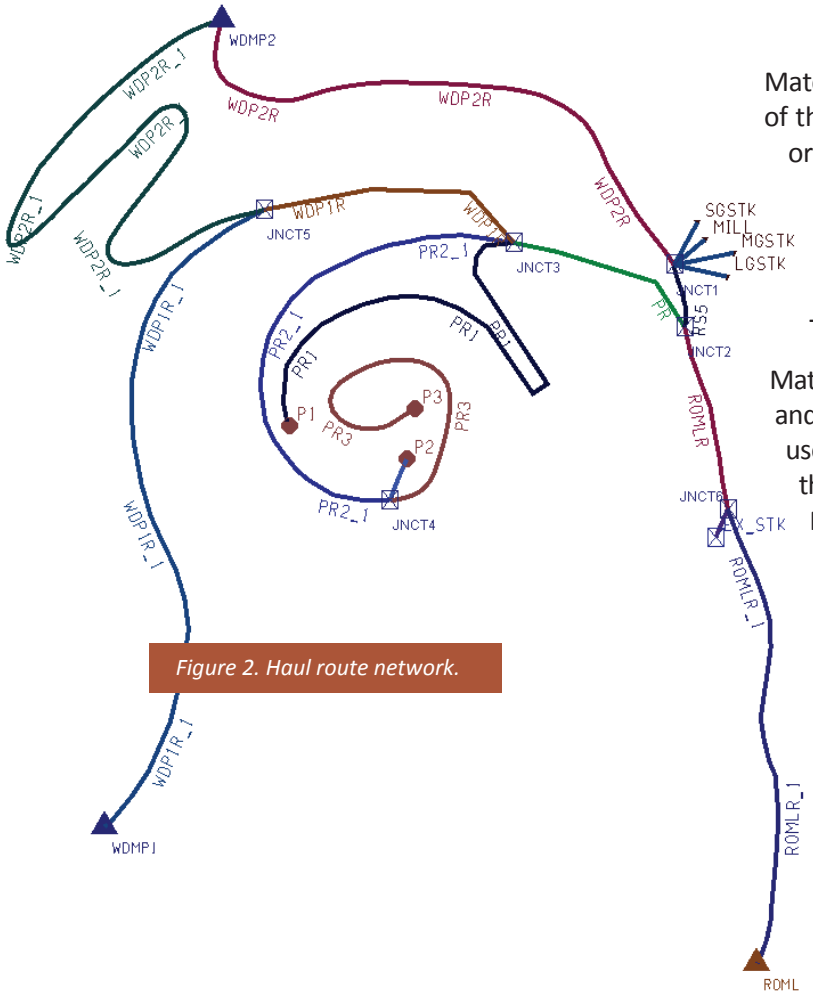

Figure 2. Haul route network.

Material routing plays a significant role in achieving the goals of the STP schedule. Thus, a haul network must be created in order to calculate and evaluate haul distances, grades, rolling resistances, and cycle times which contribute to the STP. This haul network is formed by creating attributed material sources, intersections, and destinations (points) interconnected with haul routes (polylines) in MS3D. This data is then imported into the MSPD via MSHaulage.

Material source, destination, route and equipment parameters, and constraints are entered in MSHaulage. These values are used in MSSO to produce a schedule partially based upon the haul network information. The values are also used in MSHaulage for material movement to verify destination capacities, route availability, and equipment requirements. This is particularly important when unexpected changes in material source/destination or route availability has changed. Some of the material movement options available in MSHaulage are:

1. Material availability for a given phase or period: source, destination
2. Route type: inbound, outbound, one-way
3. Material overrides: must go (routing), must use (destinations or equipment)

Step 3 Schedule Mining Cuts Using MSSO

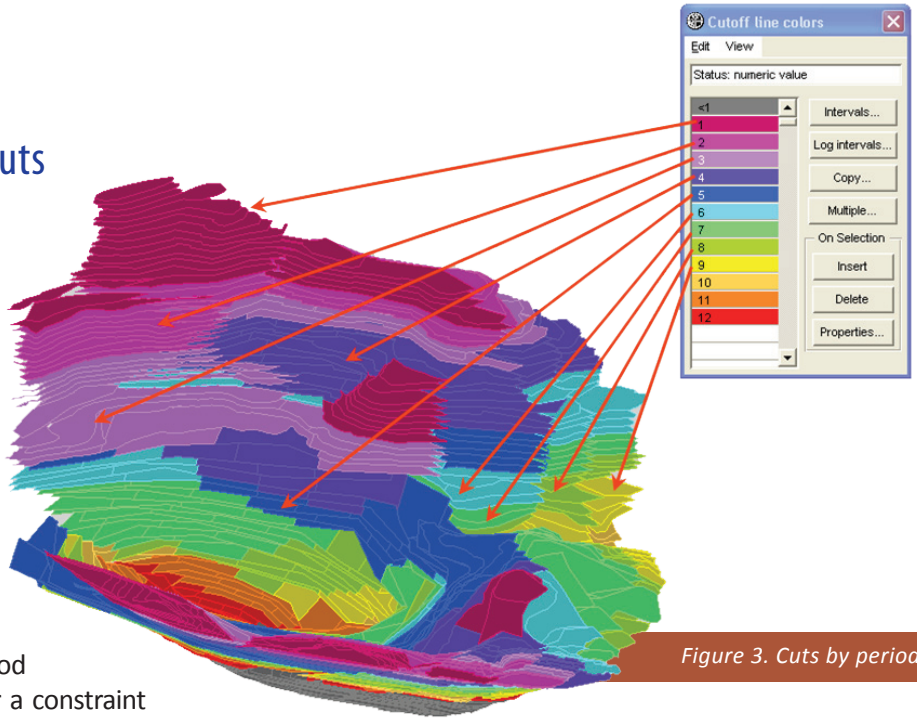

Figure 3. Cuts by period.

Using the previously created mining cuts and haul network as a foundation for the schedule, MSSO can schedule (sequence) the cuts on a "per period" basis while satisfying defined objectives, requirements, and constraints (ORCs).

Generally, any data that can be stored in the block model may be used as an objective (a value to minimize or maximize like NPV or metal content), a requirement (e.g., must mine 20,000 tonnes of material "x" per period and must contain an average grade of "y"), or a constraint (e.g., limit stripping ratio to < 0.2 for periods 3-7). An important feature in MSSO is the ability to specify not only the period, but also the pits and phases to which they apply. For example, you can specify that only material from pit A and phase 1 is mined during periods 1-5, and material from pit B and phase 1 and 2 during periods 6-8, and material from both pits and all phases during periods 9-12.

Options that can be used as a minimum or maximum in MSSO include:

- Net present value
- Milling capacity
- Average grade
- Mineral content
- Stockpile (from/to)
- User-defined item(s)
- Mining capacity
- Stripping ratio
- Other ratios (rock type, etc.)
- Vertical advance rate
- Number of cuts
- Truck/shovel/auxiliary equipment hours

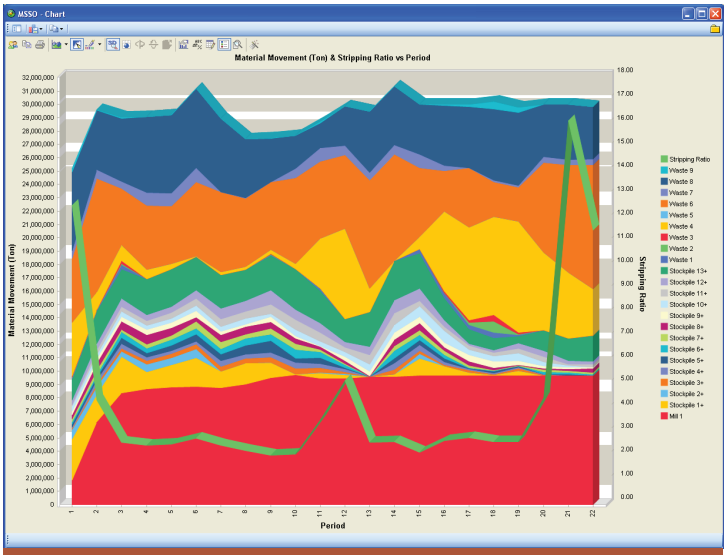

Figure 4. MSSO Charting tool - Material Movement and Stripping Ratio as a function of Period .

Analysis of the schedule is performed via various methods in MS3D and MSSO:

1. Visual inspection: using MS3D to ensure that the cut sequence is geometrically feasible
2. MSSO Reporting tool:
   - Full - detailed information for all cuts
   - Summary - schedule information per period
   - Stockpile - material incoming/outgoing/ending balance, per period
3. Graphically: using the MSSO Charting tool to create graphs which display schedule information by period or some other schedule parameter.

Using these methods together, you can easily verify that the mining schedule adheres to the defined ORCs.

Step 4 Design & Export BPs Using MS3D BPE

MS3D is used to design, plan, and export blast patterns. The planned patterns completely satisfy all mining, fragmentation, safety requirements, and constraints. After checking the pattern, the blasthole coordinates, length, and type are exported in a format to be used by surveyors, drillers, and blasting crews.

Step 5 Use MSAxis D&B

MSAxis D&B focuses on drill and blast design and management. It relates drill and blast data to associated processes downstream, getting the best out of mining and processing equipment.

Check BPs

Blast patterns are checked to ensure that blasthole burden and spacing, depth, type, location, explosive parameters, and other requirements have been met.

For example, planned blasthole locations are compared against previous blasthole locations which may have "bootlegs" where the toe of a previously detonated blasthole had explosive material that was not entirely consumed, thus creating a safety threat. If the planned and previous blasthole coordinates are too close, the safety hazard can be mitigated by offsetting the planned blasthole by some distance.

Import Actual BPs

After blastholes have been drilled, the actual locations and other drilling information (such as penetration rate, bit usage, and explosives used) is imported and stored in the MSPD. This information will be utilized later in the STP process to help establish future pattern equipment and materials estimates; as well as ensure that future pattern designs meet or exceed defined ORCs.

Calculate KPI for Actual BPs

KPI data is information about individual blastholes such as rock hardness, penetration rate, area of influence, and drill bit consumption. When these values are compared to post-shot material fragmentation and other parameters, you can evaluate the effectiveness of the blasthole parameters and modify future BPs as necessary.

Report Blasthole Information

Blasthole, KPI, and related information is reported using SQL Server Reporting Services (SSRS). These reports allow you to graphically view blasthole information for one or more patterns at the same time. When doing so, comparisons may be performed to evaluate drilling productivity and pattern design results. Types of data reported include:

- Percent overdrill
- Rock hardness
- Drill XY location offset percentage
- Stemming depth
- Total drill time
- Target depth
- Consumables used

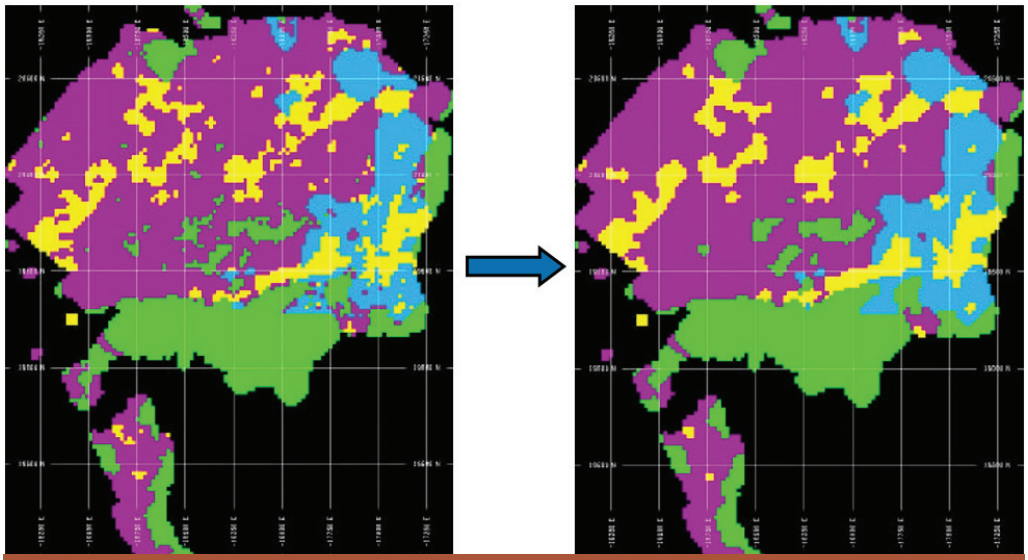

Figure 5. Per block destination classification (before) and "optimized" block classification (after).

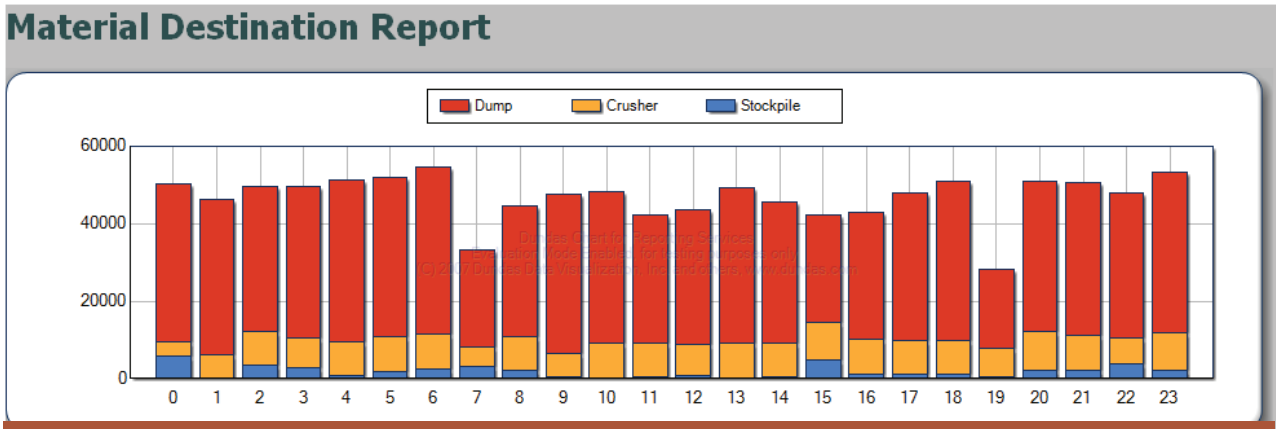

Figure 6. Material Destination Report – tons vs. period.

Model Actual Blast Pattern KPI Data

As part of the BP planning process, a block model is interpolated using calculated KPI data. This information is then used to estimate future BP costs and equipment requirements, and like the KPI data, you can modify future BP plans, as necessary, to deal with fragmentation requirements, changes in rock type, moisture content, and safety concerns. By accounting for known information in future BPs, you can reduce crushing requirements, excess drilling, explosives usage, and unexpected equipment failure.

Step 6 MSAxis GC

MSAxis GC harnesses the tools necessary to import grade control data, to model and determine material classification, and to perform field demarcation. It improves classification and material destination assignment, as well as enhancing grade processing and calculations.

Optimize Material Classification

Typically, as part of the mine planning process, material destinations are coded to each mining block based on items such as grade or rock type. Generally, these grade control block models have smaller blocks than exploration or planning model blocks, so mining equipment is not able to mine and send each block to the coded destination. Instead, each bucket load will consist of several partial blocks. It then becomes necessary to optimize the "per block" classification and transform it into a mineable/generalized classification. Mining shape optimization considers minimum mining width, block grades, costs, recoveries, and geological information to determine the best destination for groups of blocks to be mined together. The blocks are coded with the optimum calculated destination code. The result of this "destination" optimization is shown in Figure 5 (previous page).

Create Material Routing Cuts (MRC)

With the grade control block model, MSIP is used to create mining cuts around the groups of similarly coded blocks, identifying them to be sent to a specified destination.

Confirm Material Classification

Ore control personnel have the ability to design material routing cuts having shapes differing from the general outline created in the optimized classification previously performed. Because of this, you should verify that the material in each cut is routed to the destination satisfying the ORCs as well as maximizing profit. This verification is performed using the MSIP-ARM script which evaluates the grade control blocks within the defined cuts and, based upon user-defined parameters, calculates the best destination for the cut. The model can be automatically coded with this destination and attribute values can be stored to the cut.

Report Cut Reserves

Cut characteristics such as average grade, tons, and other user-defined information can be reported in MSIP using one of the many reporting scripts that are included with MineSight.

SOLUTION OVERVIEW

Mintec, Inc. has developed a suite of tools which helps the short term planner meet the challenges of material scheduling and routing. These tools are easy to use and provide the required flexibility when faced with grade, blending, stripping, environmental, and other requirements. Through the use of MSIP and SQL reporting services, cut and blasthole information can be reported and used for planning and evaluation purposes. For more information on how to create or optimize your short term plan, or on any of the short term planning tools, please contact Mintec Technical Support: ts@mintec.com.